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Microstructure of $CaCu_3Ti_4O_{12}/SrTiO_3$ and $CaCu_3Ti_4O_{12}/BaTiO_3$ multilayered thin films grown on $LaAlO_3$ (100) substrates for dielectric tunability

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$CaCu_3Ti_4O_{12}$(CCTO)/$SrTiO_3$(STO) and $CaCu_3Ti_4O_{12}$(CCTO)/$BaTiO_3$(BTO) films multilayered heterostructures were successfully synthesized on $LaAlO_3$ (LAO) (100) substrates via a sol-gel method. The annealing temperature was fixed at 800 ℃ for one hour for each deposition. Our films were deposited with conditions as follows; CCTO/CCTO/CCTO/CCTO, STO/STO/STO/STO, CCTO/STO/CCTO/STO (1L-CCTO/STO), CCTO/CCTO/STO/STO (2L-CCTO/STO), CCTO/CCTO/BTO/BTO (2L-CCTO/BTO) and CCTO/BTO/CCTO/BTO (1L-CCTO/BTO) on LAO substrates. From X-ray diffraction patterns, it was concluded that the CCTO, STO films and their multilayers deposited on LAO (100) substrates tend to be predominantly (h00) oriented, whereas BTO and its multilayers show polycrystalline orientations. Based on our analysis, CCTO films have a cubic structure with estimated lattice parameters of 7.376 Å (3.688 Å) and for STO with estimated lattice parameters of 3.888 Å, while LAO has a pseudo-cubic structure with a calculated lattice constant of 3.790 Å. Interestingly, the TiO_2 commonly presented as an impurity phase in CCTO films was suppressed in CCTO/STO multilayered films. The surface morphology and the interface layers of the films were characterized by FE-SEM technique. For electrical measurement, 1L-CCTO/STO and 2L-CCTO/STO have dielectric constants of 1000 and 820 at 100 kHz, respectively. The loss tangent values measured at the frequency above 10 kHz of both 1L and 2L-CCTO/STO films are approximately 0.07. Despite being stacked up with non-tunable dielectric materials, 1L-CCTO/STO thin films can be tuned in range of 1.6% at 10 kHz.

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